Supplementary material

S1: Artificial Neural Network

$$CH_{4fluxnorm} = w_{12} + w_{13} \cdot \tanh(S_1) + w_{14} \cdot \tanh(S_2) + w_{15} \cdot \tanh(S_3) \quad \text{(S1)}$$

where $CH_{4fluxnorm}$ is the normalized CH_4 flux, and

$$S_1 = w_0 + \sum_{i=1}^{3} w_i v_{j,norm} \quad \text{(S2)}$$

$$S_2 = w_4 + \sum_{i=5}^{7} w_i v_{j,norm} \quad \text{(S3)}$$

$$S_3 = w_8 + \sum_{i=9}^{11} w_i v_{j,norm} \quad \text{(S4)}$$

with j=1→3

where v_1 to v_3 correspond to change in total static pressure (sum of change in water level and change in atmospheric pressure), total static pressure (water depth + atmospheric pressure) and bottom temperature, respectively; with

$$v_1,norm = x_1 + x_2 * v_1 \quad \text{(S5)}$$

$$v_2,norm = x_3 + x_4 * v_2 \quad \text{(S6)}$$

$$v_3,norm = x_5 + x_6 * v_3 \quad \text{(S7)}$$

All weights w_i are given in Table S1 the weights w_0, w_4, and w_8 being linked to the bias neuron (constant term equal to 1).

The resulting CH_4 ebullition is finally calculated (in $mmol.m^{-2}.d^{-1}$) using:

$$CH_{4ebullition} = x_6 + x_8 * CH_{4fluxnorm} \quad \text{(S8)}$$

where x_j are the normalization coefficient, given in Table S2.

Table S1. Weights for CH_4 ebullition modeling with neural network parameterization

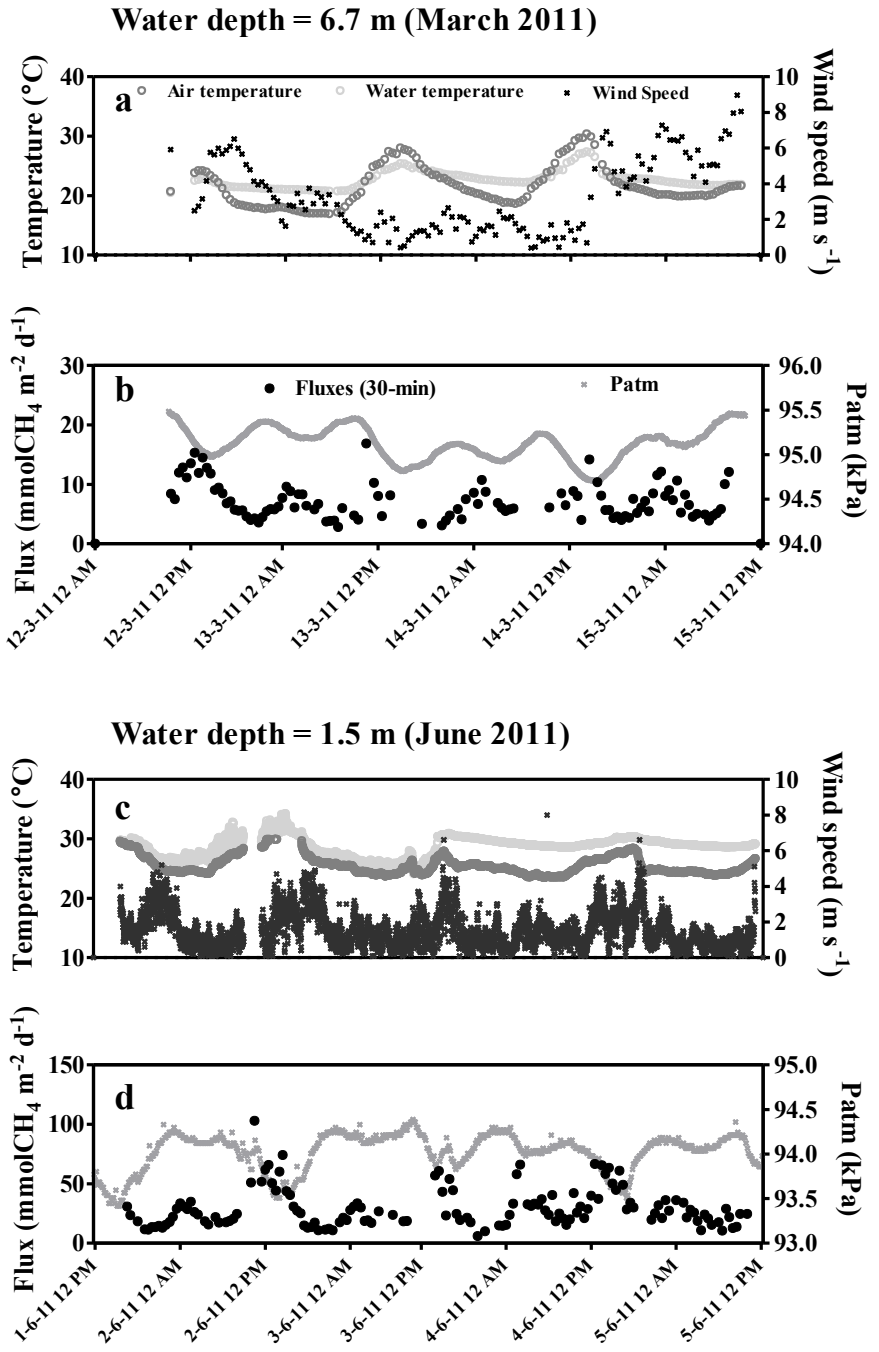
	Weights
$w_{(0)}$	-0.735741
$w_{(1)}$	-1.93496339
$w_{(2)}$	-1.54455293
$w_{(3)}$	-0.38119742
$w_{(4)}$	0.67514498
$w_{(5)}$	1.81679708
$w_{(6)}$	0.30915645
$w_{(7)}$	-0.31561338
$w_{(8)}$	0.76193471
$w_{(9)}$	0.98635468
$w_{(10)}$	0.7621441
$w_{(11)}$	0.20152095
$w_{(12)}$	0.92422681
$w_{(13)}$	-1.2168297
$w_{(14)}$	-1.0238241
$w_{(15)}$	-1.92242616

Table S2. Normalization coefficients for CH_4 ebullition modeling with neural network parameterization

Normalization Coefficients	
x_1	0.3872344
x_2	12.520561
x_3	-4.370062
x_4	0.302245
x_5	-11.117316
x_6	0.557007
x_7	9.066059
x_8	9.029213

Table S3. Details of the meteorological and physical conditions at the eddy covariance site during the four different deployments. Average, standard deviation, and range are given for all variables.

	March 2009	March 2010	March 2011	June 2011
Water depth (m)	~10	~10.5	~6.7	~1.5
Wind speed ($m.s^{-1}$)	2.4 ± 1.1 (0.3−6.7)	2.9 ± 2.3 (0.2−10)	3.0 ± 1.9 (0.2−7.3)	1.4 ± 0.9 (0.2−4.3)
Friction velocity, u_* ($m.s^{-1}$)	0.25 ± 0.11 (0.07−0.7)	0.21 ± 0.11 (0.03−0.59)	0.19 ± 0.12 (0.02−0.47)	0.15± 0.08 (0.02−0.39)
Relative humidity (%)	77 ± 9 (47−91)	66 ± 14 (35−86)	72 ± 11 (45−87)	73 ± 15 (20−93)
Air temperature, T_{air} (°C)	25 ± 2 (23−30)	23 ± 4 (16−33)	22 ± 3 (17−30)	26 ± 2 (24−30)
Water temperature, T_{water} (°C)	29 ± 1 (28−31)	24 ± 2 (21−30)	23 ± 1 (21−27)	29 ± 2 (25−32)
T_{water}-T_{air} (°C)	3.6 ± 1.2 (0.2−6.2)	1.0 ± 2.6 (-5.7−5.2)	1.5 ± 1.9 (-3.1−3.9)	2.9 ±1.5 (0.2−5.3)
Net shortwave radiation ($W.m^{-2}$)	141 ± 200 (-3−634)	114 ± 169 (-4−551)	219 ± 314 (-6−880)	149 ± 253 (-5−1018)
Net longwave radiation ($W.m^{-2}$)	-28 ± 11 (-49− (-6))	-43 ± 9 (-63− (-10))	-75 ± 8 (-88−(-48))	-38 ± 15 (-61− (-6))
Net radiation ($W.m^{-2}$)	90 ± 188 (-51−596)	67 ± 171 (-60−497)	117 ± 307 (-94−777)	110 ± 251 (-66−1011)



1

2

3 Figure S1. Time series of CH_4 emissions measured by eddy covariance (DE_{EC}) (b, d), wind
4 speed (a, c), air temperature (a, c), surface water temperature (a, c) and atmospheric pressure
5 (b, d), obtained during the March and June 2011 field campaigns. Note the difference in the y-
6 axis scale between the two field campaigns.

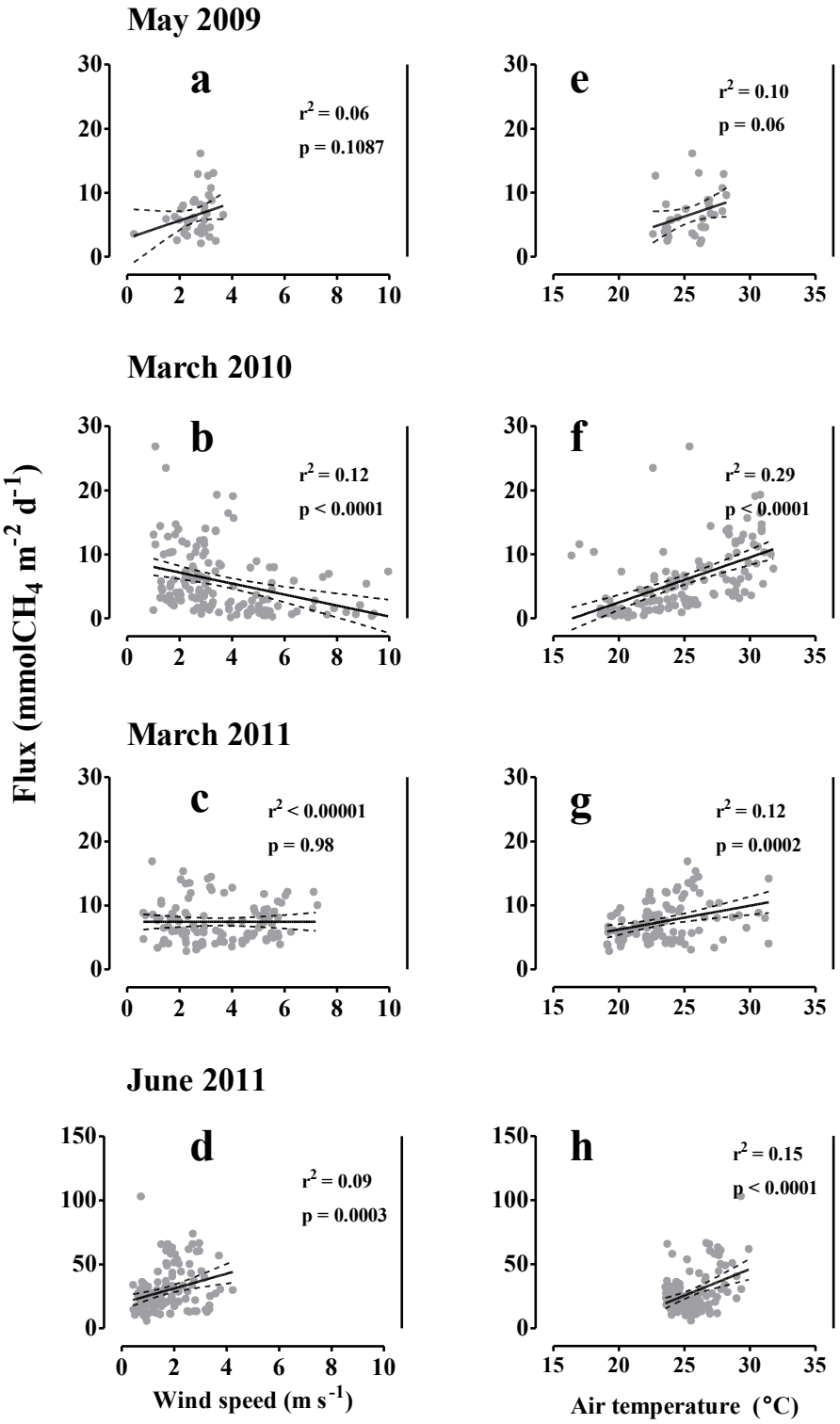
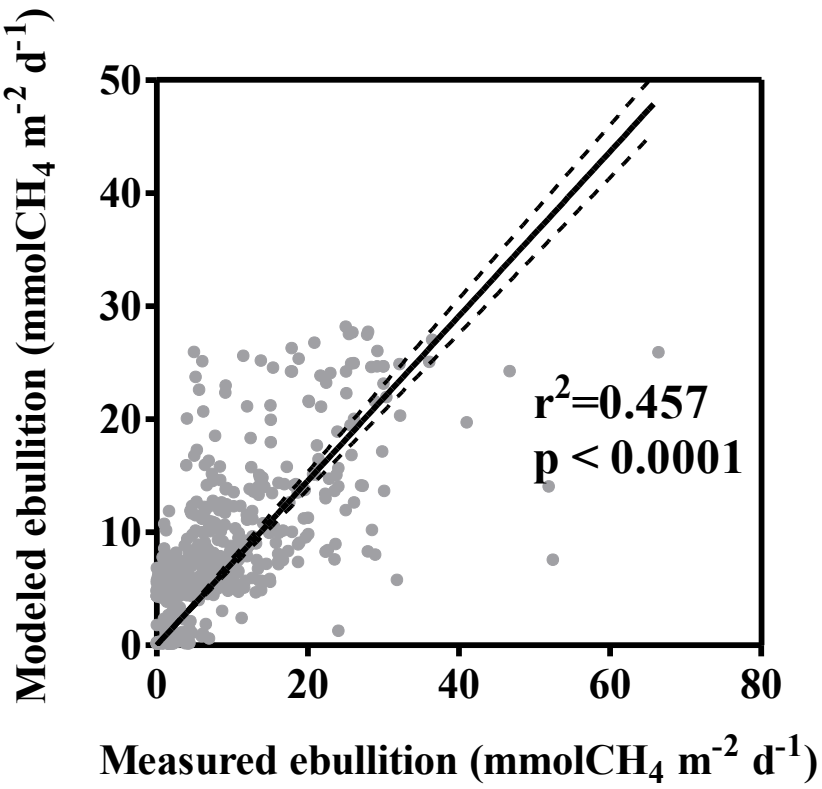


Figure S2. CH_4 emissions measured by eddy covariance (DE_{EC}) versus wind speed (a, b, c, d) and air temperature (e, f, g, h) for the four field campaigns. Note that y-axis scale differs for June 2011.



1

2

3 Figure S3. Funnels versus ANN modeled ebullition fluxes.